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FEASIBILITY TESTS OF USE OF THE TRI TURBO-3 AIRCRAFT FOR ARCTIC--ETC(U)

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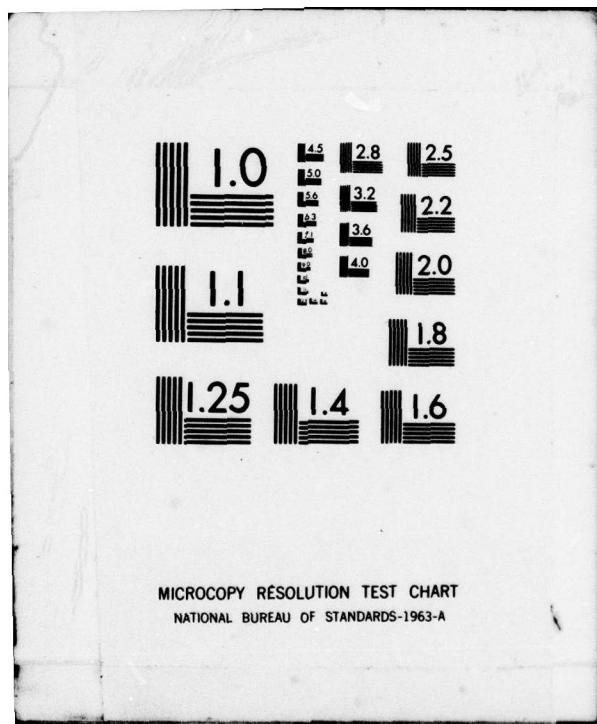
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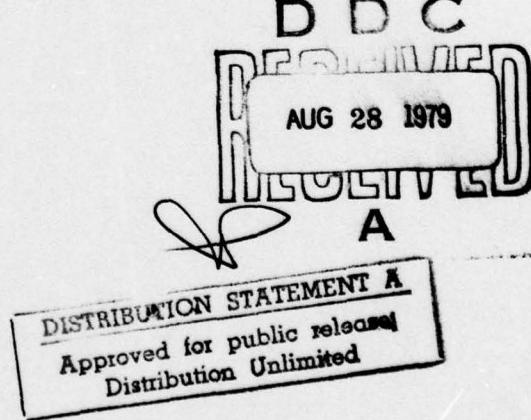
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Feasibility Tests of Use of the
Tri Turbo-3 Aircraft for Arctic AXBT
Drops

B. M. Buck

See 1473 in back.



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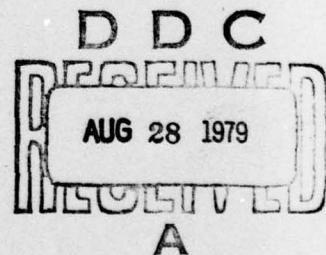
**Feasibility Tests of Use of the
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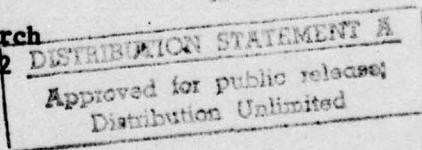
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Polar Research Laboratory, Inc.
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PRL TR19
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ABSTRACT

Field feasibility trials of the new Arctic Tri Turbo-3 aircraft were conducted as part of ONR's "Arctic East" Program in the Eurasian Basin. One of these trials was a test of its usefulness to collect temperature profiling data in the Greenland-Svalbard Strait in support of underwater acoustics studies. This report describes the aircraft facilities, dropping techniques and results of trial drops.

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INTRODUCTION

The Office of Naval Research is conducting a long-term program of scientific investigations in the Eurasian Basin of the Arctic Ocean. Concentrated field experiments are to be carried out in the spring months, when flying conditions are good, using Nord, Greenland as the forward base for logistic support of the effort. Arctic East-79 was the first of such experiments. Aircraft requirements for the experiments are multi-faceted and cover, for example: parachute air drops of thousands of pounds of fuel and explosives to manned ice camps; establishment and support of ice camps out to a range of several hundred miles using ice landings on unprepared strips; landings on the ice for the installation of automatic data buoys; airdrop of data buoys and other flying chores. A unique aircraft is needed to meet some of these requirements, especially those requiring very long-range flights with significant cargo weights, landing on ice. These requirements are being tested by a Tri Turbo-3 aircraft, a C-47 converted to a three turboprop engine configuration, which saw service on the three-month Arctic East-79 experiment. One of the aims of that experiment was to test this aircraft for the general, multipurpose logistical roles needed to support the scientific effort and to determine whether it met the above requirements. This report deals with one facet of the plane - i.e., its ability to provide support in underwater acoustics study.

One of the main scientific projects of the Arctic East Program is underwater acoustics, and an important input to that study is the sound velocity profile (SVP) of the water column along acoustic propagation paths under investigation. Although the Central Arctic has a relatively stable SVP, the southern periphery of that ocean and its bounding seas do not. Considerable variations have been observed in the limited measurements of those areas. This is especially true of the Marginal Sea Ice Zone (MIZ)-defined as those areas at the southern edge of the pack ice bounded by the minimum (summer) and maximum (winter) extents of the pack.

Although only a first order approximation of the SVP can be obtained from temperature profile measurements, and salinity measurement is required for close accuracy, temperature alone is sufficient for low-frequency acoustics studies. Because of this, the Airborne Expendable Bathythermograph (AXBT)

is a powerful tool in assessing the acoustic propagation characteristics of an ocean area. Because it is in quantity production for Navy operational uses it is economical, and its airdrop design allows rapid, wide area and, if desired, repeated coverage. Its absolute accuracy is poor (about $\pm .55^{\circ}\text{C}$) compared with scientific oceanographic instrumentation but sufficient for studying media layering and its effects on low-frequency acoustic propagation. The maximum length of wire in the AXBT is 1000 feet (305m), which is also sufficient for most Arctic areas.

EXPERIMENT

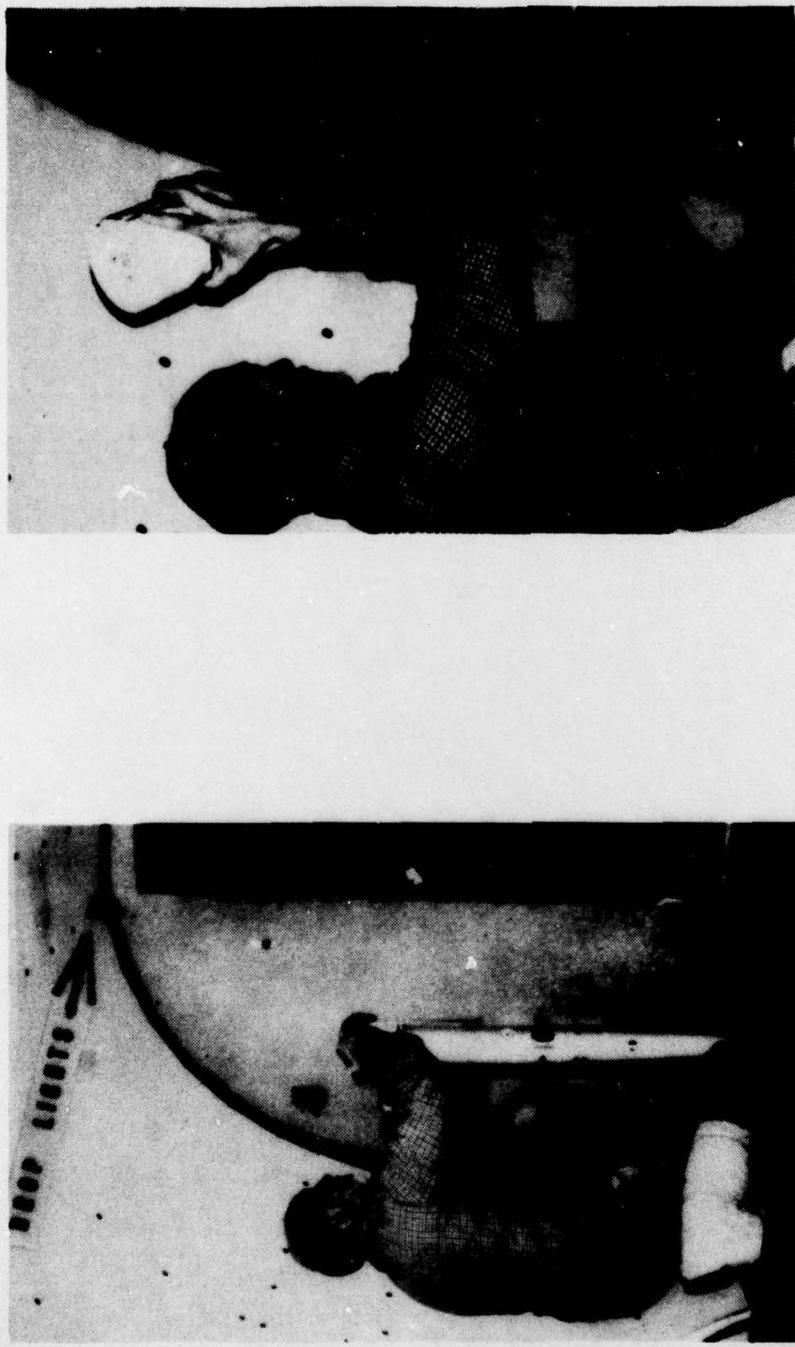
For the above reasons, and because the Tri Turbo-3 was a dedicated aircraft for the whole of Arctic East-79 and therefore available for AXBT drops when not employed for ice station and other logistics support tasks, it was decided to equip it for AXBT drops and test the concept during the first Arctic East experiment. This included the installation of a launch tube (also suitable for MK61 and MK82 SUS drops) with pilot-actuated "standby" and "drop" lights, a removable sonobuoy receiving antenna mounted on the belly of the plane, a VHF radio receiver, and a tape recorder. Figure 1 shows the aircraft making a test drop in the Santa Barbara Channel prior to the arctic trials, and Figure 2 shows two photographs of the launch tube taken inside the plane during an actual arctic drop. The entire AXBT operation can be accomplished by one man who in a typical procedure removes the unit from its container while the pilot locates a lead, drops on light command, and then, after launch, tunes the radio and starts the tape recorder. (After striking the water it takes a couple of minutes for the AXBT to actuate and drop its probe, during which time the above can be accomplished).

The AXBT probe drops at a rate of five feet (1.52m)/sec (± 0.25 feet/sec) and, depth is analyzed on the basis of that rate. The maximum depth is 1000 feet (305m), which is reached in three minutes 20 seconds, and the analysis should be truncated at that time even though the tone may continue for a considerable time afterwards because not all probes break the wire when reaching the end. Since most Arctic Ocean water is isothermal below 1000 feet (305m) one can be misled into thinking the device is still making a valid measurement after three minutes 20 seconds. In fact, some AXBTs may actually have wire in excess of 1000 feet, but since this cannot be relied on one should stop at 1000 feet.



FIGURE I TRI TURBO-3 LAUNCH AIRCRAFT

FIGURE 2 LAUNCH TUBE IN AIRCRAFT



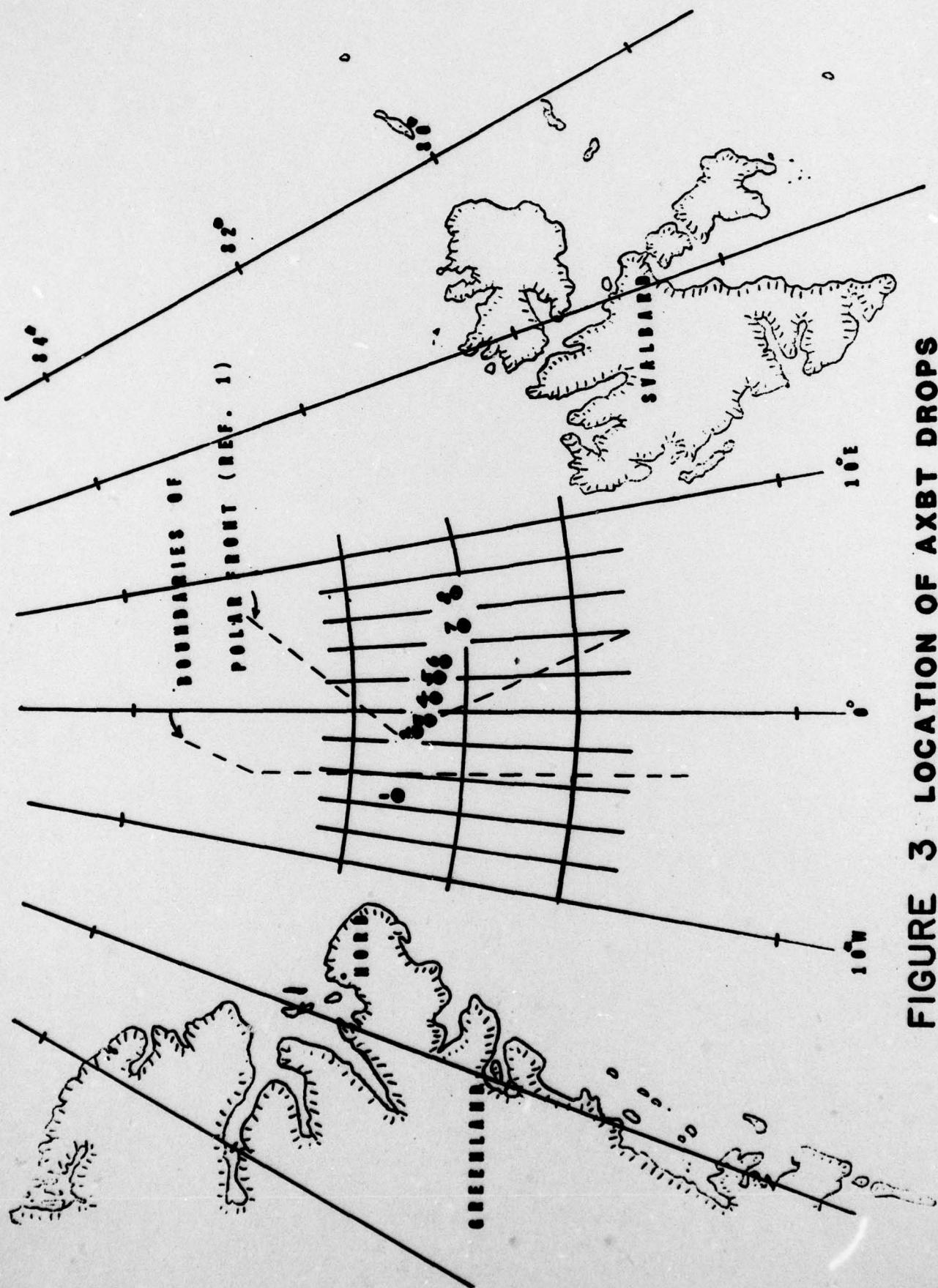


FIGURE 3 LOCATION OF AXBT DROPS

The radio signal from the AXBT is frequency modulated according to the following:

$$F \text{ (Hz)} = 1440 + 36 T \text{ (}^{\circ}\text{C)}$$

At 0°C the modulation is 1440 Hz, a frequency easily tape recorded on a common cassette tape recorder. To play back this tape for analysis we used the simple expedient of a digital spectrum analyzer capable of analyzing and scope-displaying frequency versus time. Several other readily available methods could be easily employed (e.g., discriminator/chart recorder, analog to digital converter/computergraphics, and frequency counter/recorder.)

During the MIZLANT-77 experiment, Newton investigated the Greenland-Svalbard Strait using aircraft landings on the ice to deploy both XBTs and a lightweight profiler system for CTD measurements. The results, which are given in reference 1, define a polar front in the areas shown by dashed lines in Figure 3. Newton's measurements were mostly in the northwest section of the strait but with some P3 launched AXBT data on the east side. Therefore, it was decided to locate the feasibility drops by the Tri Turbo-3 mostly to the east of the polar front to supplement Newton's data. Figure 3 shows the drop locations of the eight AXBTS.

The AXBTs used were from two different manufacturers, one set on sonobuoy channel 12 (170.5 MHz) and the other on channel 16 (173.5 MHz).

RESULTS

It was possible to find open-water or thin-ice leads at or close to all of the targeted drop positions. However, some of these leads were quite small and required very low and slow overflights (some drops as low as 200 feet and well under 100 knots) by the Tri Turbo-3 to enable accurate drops. The lights and launch tube performed very well, and no AXBTs failed to enter the leads they aimed for. The pilot was able to do a very good job of judging the drop times and aborting for another pass when conditions were not exactly right. During the first few drops the plane remained at low altitude for the five to eight minutes required for the AXBT to airdrop, deploy the probe, and telemeter the data. However, to remain in the vicinity for radio reception required turns during which the radio signal was sometimes lost because the low wing obscured the belly-mounted antenna. To solve this

1. J. L. Newton "Oceanographic Observations in the Northwest Greenland Sea: March-April 1977 Preliminary Results," NOSC/TN310, 30 September 1977.

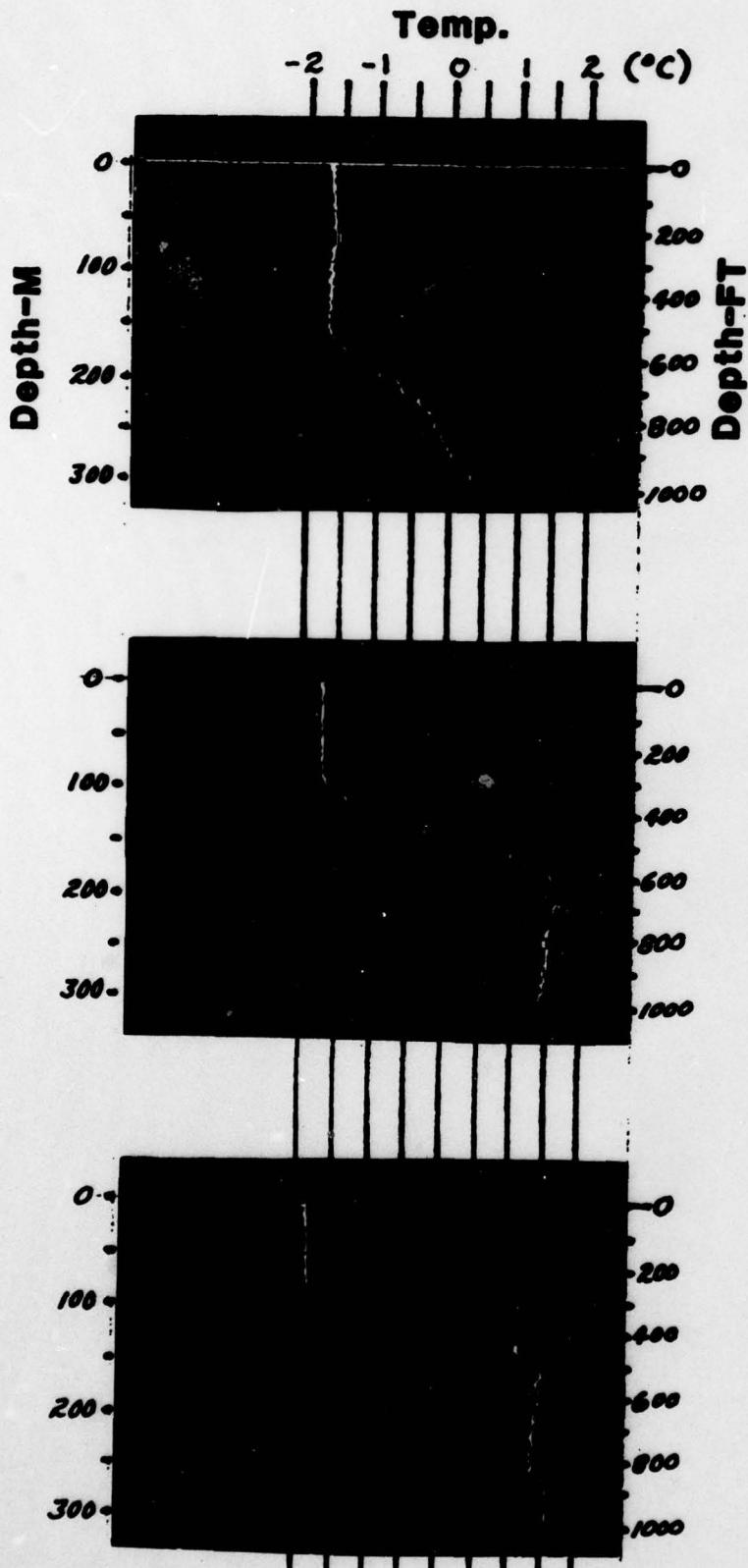
problem a new technique was tried which worked very well. The aircraft dropped at low altitude and then climbed rapidly to over 1000 feet (305m) during the two-three minutes it took for the corrosive link in the AXBT to dissolve and drop the probe. With its three Pratt and Whitney PT6-45 engines and light load during the drops, the Tri Turbo-3 was ideally suited for this procedure.

Despite the success of the plane for the drops, the Channel 16 AXBTs were unsatisfactory in five trials. Either the signal failed completely to appear, was weak, or transmitted immediately upon striking the water (not allowing time for the plane to climb). The Channel 12 version worked very well however.

Figure 4 gives the temperature versus depth results on nine Channel 12 AXBTs. The second AXBT graph at Station 7 shows a malfunction and is included to demonstrate the type of AXBT failure that can occur. The malfunction is obvious from the first Station 7 trace shown immediately above this one—which was dropped in the same lead—and from an inspection of the smooth transition of water types from all of the AXBTs. Of the 10 AXBTs "dropped for record," only one other Channel 12 unit failed (no signal received). The latter type failure is obvious to an operator listening for the tone, but the malfunction at Station 7 is harder to catch orally. For this feasibility trial no provision was made for a real-time readout of the temperature/depth, and only tape recordings were used. However, in future data collection, such a capability is necessary to detect this type of malfunction.

The skip in the trace at Station 4 between about 600 and 800 feet (183-244m) was caused by a loss of radio signal from the AXBT, probably caused by a too-steep turn of the aircraft which shadowed the antenna.

Evidently, the demarcation of the polar front estimated by Newton in reference 1 is reasonably accurate in the area of our trial AXBT drops. This is adduced from the marked differences of the Station 1 trace (the only one to the west of the front area) from the remaining ones to the east. Obviously, Station 1 is typical polar water. AXBT "cuts" through the front both north and south of that used would be of considerable interest in



Station 1

Lat $81^{\circ} 34.0' \text{ N}$

Long $05^{\circ} 16.1' \text{ W}$

Station 2

Lat $81^{\circ} 26.7' \text{ N}$

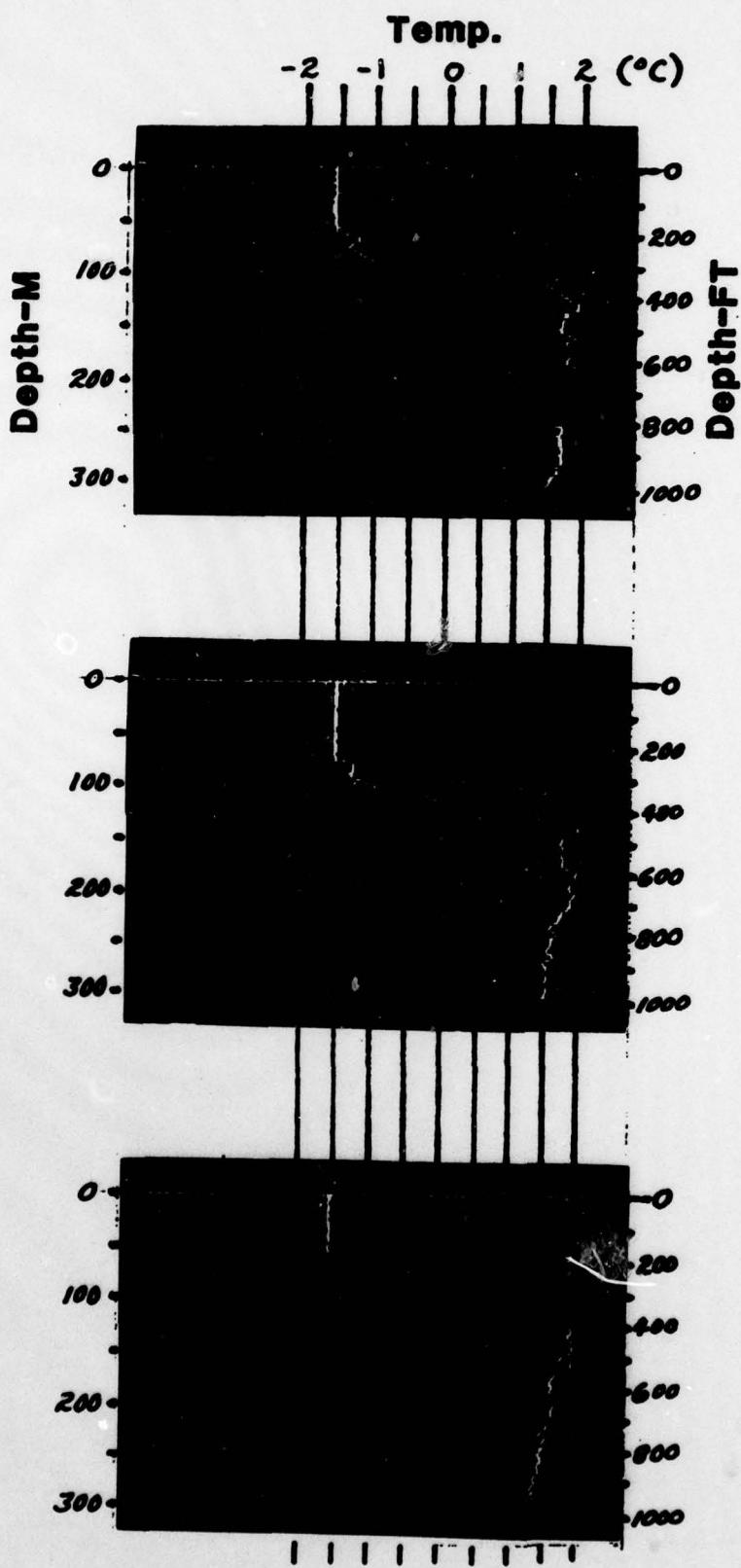
Long $01^{\circ} 19.2' \text{ W}$

Station 3

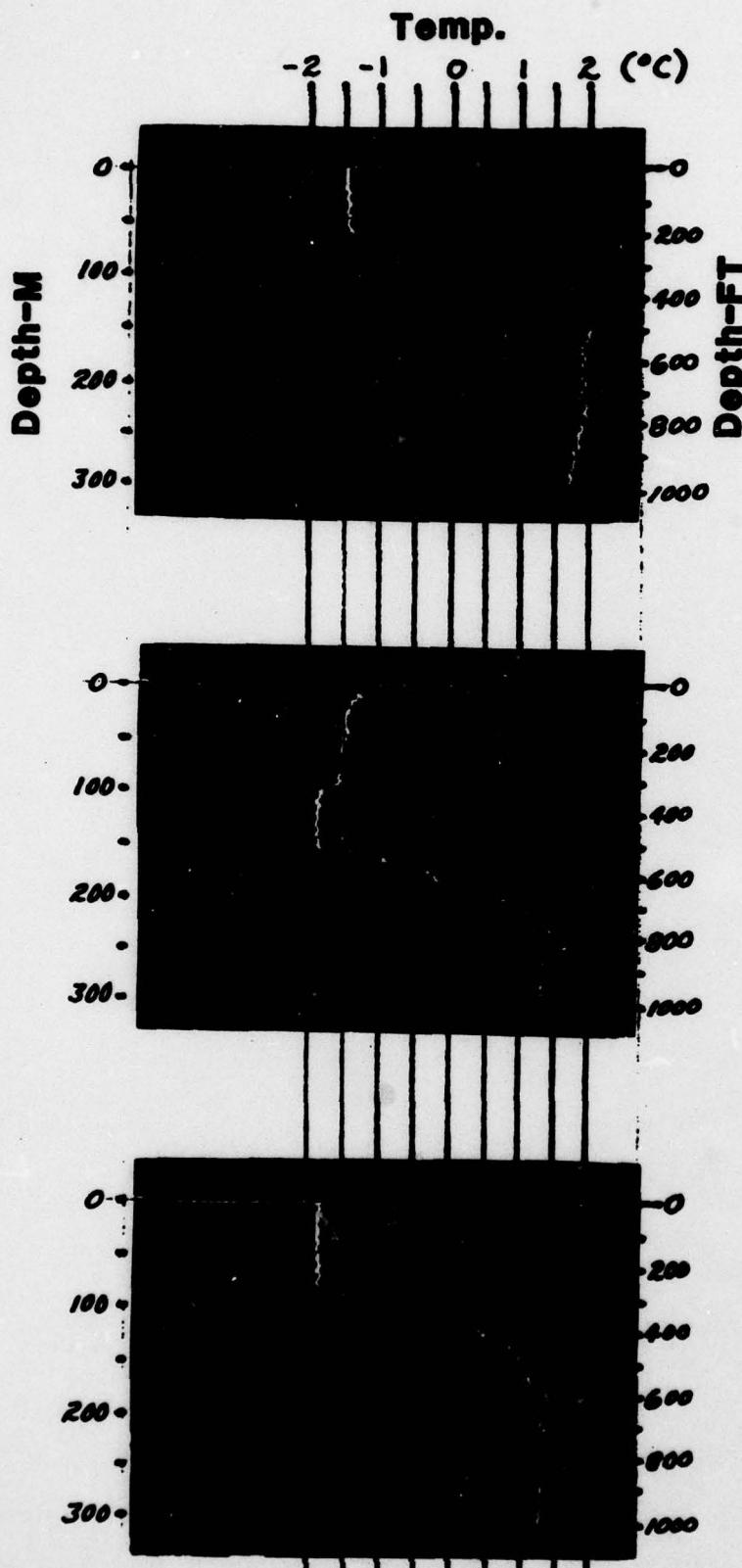
Lat $81^{\circ} 20.1' \text{ N}$

Long $00^{\circ} 26.9' \text{ E}$

FIGURE 4 AXBT TEMP. VS DEPTH TRACES



(FIG.4 CONT.)



Station 7

Lat 81 $^{\circ}$ 00.4' N

Long 05 $^{\circ}$ 00.3' E

Station 7

Lat 81 $^{\circ}$ 00.3' N

Long 04 $^{\circ}$ 59.1' E

AXBT malfunction -
see text

Station 8

Lat 81 $^{\circ}$ 04.3' N

Long 07 $^{\circ}$ 00.2' E

FIG.4 CONT.)

determining the structure and the stationarity of the polar front-but this will have to wait for future opportunities in the Arctic East Program.

It is concluded that, with the addition of a real time plotter, the present configuration of the Tri Turbo-3 for AXBT drops is highly satisfactory for gaining valuable temperature profile information in support of the acoustics program. A more extensive field experiment for the collection of these data should be implemented.

ACKNOWLEDGEMENT

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